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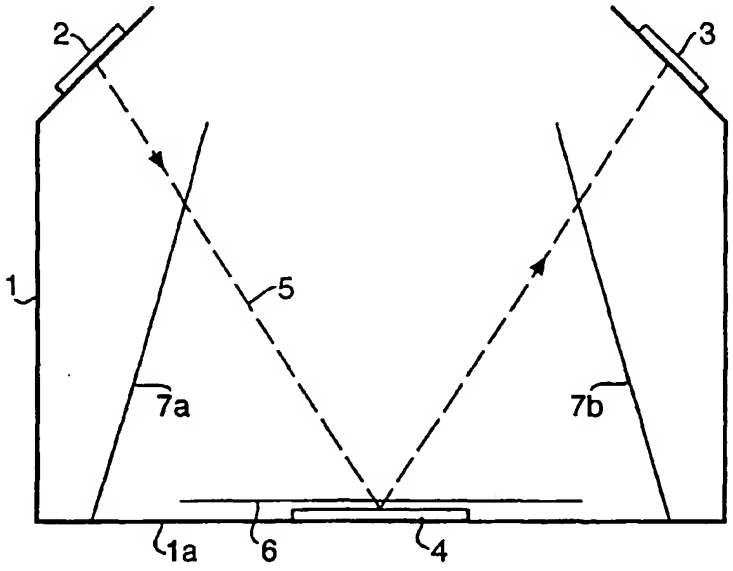
(54) Title: A SHEET STACKING HOPPER




(57) Abstract: A sheet stacking hopper (1) having a base (1A) in which sheets are stacked in use; and a sheet detection system comprising a pair of transducers (2, 3). The first transducer (2) emits energy and the second transducer (3) is sensitive to this energy. At least one reflector (6) is arrange to reflect the emission from the first transducer (2) so that it can be detected by the second transducer (3). The emission from the first transducer (2) is intercepted and modulated, if a sheet (6) is present in the energy path between the first and second transducers. The transducers and reflector (s) are located such that the emission from the first transducer (2) is intercepted by a sheet (?) stacked on the base (IA) and by a sheet (7a) resting in a non-stacked manner in the hopper.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# A SHEET STACKING HOPPER

The present invention relates to sheet stacking hopper.

In sheet handling systems, particularly systems for handling documents of value such as banknotes, it is important to be able to determine whether sheets remain in a hopper accessible to users.

Conventionally, the presence of a sheet within a sheet stacking hopper is detected by an infra-red light emitter and sensor pair, where the beam of infra-red radiation from the emitter is blocked by the presence of sheets. See, for example, JP-A-08324837.

The emitter and sensor are located such that the probability of a sheet not being detected is small. However, the possibility remains that with certain shapes of sheet or if the sheet is deposited in certain orientations, or has holes or the like, the sheet may not intercept the beam of infra-red radiation and hence, will not be detected.

It is known that the probability of detecting a sheet can be enhanced by using additional infra-red emitter and sensor pairs. This has the effect of increasing the number of infra-red radiation beams that can be intercepted by the sheets and by appropriate positioning of the emitters and sensors, the region within which a sheet will be detected can be made larger.

However, a significant disadvantage of this is that the cost increases rapidly due to the necessity to add extra emitters and sensors and associated electronics.

US-A-5745817 also discloses the use of an infrared light emitter and sensor pair in conjunction with a reflector but for the purpose of detecting the passage of a sheet into a hopper.

According to the present invention, a sheet stacking hopper has a base on which sheets are stacked in use; and a sheet detection system comprising a pair of transducers,

the first transducer emitting energy and the second transducer being sensitive to this energy, and at least one reflector arranged to reflect the emission from the first transducer so that it can be detected by the second transducer, wherein the emission from the first transducer is intercepted and modulated, if a sheet is present in the energy path between the first and second transducers and is characterized in that the transducers and reflector(s) are located such that the emission from the first transducer is intercepted by a sheet stacked on the base and by a sheet supported in a non-stacked manner in the hopper.

The effect of this modulation may be that the emission is completely absorbed, reduced in intensity or even partially absorbed in the case where the emission has more than one wavelength and the sheet absorbs only one of these.

In comparison with the prior art, the invention increases the probability of detecting a sheet which is, supported, typically at rest, in the hopper but in a non-stacked manner, for example resting against a side of the hopper, without the expense of extra transducers. For example, the use of reflectors increases the number of positions within a hopper that a sheet can occupy and still intercept the emission from the first transducer.

The reflector may be located on the base. The hopper may also comprise at least one side wall and the or a reflector may be located on the at least one side wall.

Usually, the sheet stacking hopper comprises a pair of side walls, in which case a respective reflector is located on each side wall. Alternatively, a respective reflector may be located on the side wall and the base.

Preferably, the first transducer emits electromagnetic radiation and the second transducer is sensitive to electromagnetic radiation. Alternatively, the first transducer may emit, and the second transducer may be sensitive to, a mechanical vibration such as ultrasound. The particular form of energy emitted by the first

transducer would be chosen in accordance with the sheet properties.

In the event that electromagnetic radiation is used, then preferably this electromagnetic radiation will be infra-red. However, it would be feasible to use ultraviolet radiation or visible light in place of infra-red radiation.

Whilst it is possible that the energy emitted by the first transducer propagates in a diffuse manner, it is preferable that it forms a beam directed towards the or one of the reflectors, so that the path of the emission from the first transducer to the second transducer is highly constrained increasing the probability of a sheet in the hopper intercepting the entire emission.

When electromagnetic radiation is used, the or each reflector may be an optical mirror. Clearly, it would be possible to use any material capable of reflecting the electromagnetic radiation, for instance, in the case of infra-red radiation the reflector may be formed from smooth surfaced white plastic.

There is further provided sheet handling apparatus comprising at least one sheet stacking hopper according to the present invention.

This sheet handling apparatus may be a banknote handling machine, in which case the sheets to be stacked in the sheet stacking hopper are banknotes. However, the sheet handling apparatus may be a constituent part of a photocopier, in which case, the sheets to be stacked in the sheet stacking hopper would be photocopier paper.

Some examples of sheet stacking hoppers including detection systems according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a cross-sectional view of a first example of a sheet stacking hopper;

Figure 2 is a cross-sectional view of a second example of a sheet stacking hopper;

Figure 3 is a cross-sectional view of a third example of a sheet stacking hopper; and,

Figure 4 is a cross-sectional view of a fourth example of a sheet stacking hopper.

A first example of a sheet stacking hopper 1 can be seen in Figure 1. The sheet stacking hopper 1 comprises an infra-red emitter 2, for example a light emitting diode, an infra-red sensor 3, for example a photodiode, and a mirror 4, located on the base 1A of the hopper 1. An infra-red radiation beam 5 emitted from the infra-red emitter 2 is reflected by the mirror 4 so that it can be detected by the infra-red sensor 3.

When a sheet lands in the normal, stacking position 6, the infra-red radiation beam 5 is intercepted by the sheet and there is a corresponding reduction in intensity of the infra-red radiation falling upon the infra-red sensor 3.

Furthermore, if a sheet falls and rests in either of the undesired, non-stacking positions 7A or 7B then the radiation beam 5 will again be intercepted and hence, the sheet will be detected.

In the prior art example, the mirror is not present but instead the infra-red sensor 3 is located in its place. Hence, it can be seen that the prior art arrangement is only capable of detecting sheets landing in either position 6 or 7A. A sheet landing in position 7B will remain undetected.

Figure 2 shows a second example of a sheet stacking hopper 10. This also comprises an infra-red emitter 11 and an infra-red sensor 12 but this time the hopper 10 comprises two mirrors 13A,13B located on the base 10A of the hopper 10 and on a side wall 10B of the hopper 10 respectively. The infra-red radiation beam 14 emitted by the infra-red emitter 11 is reflected by mirror 13A towards mirror 13B where it is reflected a second time towards the infra-red sensor 12. In this example, the mirrors may be set at an angle to the surface on which they are mounted in

order to direct the infra-red radiation beam 14 to the desired point.

It can be seen that if a sheet lands in the normal, stacking position 15 then the infra-red radiation beam 14 is intercepted before being reflected by a mirror 13A towards mirror 13B. However, the sheet may also land in position non-stacking 16. In this instance, the infra-red radiation beam 14 is intercepted after being reflected by the mirror 13A but before being reflected by the mirror 13B. In both cases, since the infra-red radiation beam 14 has been intercepted there will be a corresponding reduction in intensity of infra-red radiation reaching the infra-red sensor 12 and hence, the presence of the note in the hopper 10 will be detected.

Figure 3 shows a third example of a sheet stacking hopper 20. This example differs from the previous two in that the two mirrors 23A and 23B are located on opposite side walls 20A,20B of the hopper 20. The infra-red radiation beam 24, emitted by the infra-red emitter 21, is reflected by the mirror 23A towards the mirror 23B where it is reflected a second time towards the infra-red sensor 22, located on the base 20C of the hopper 20.

A sheet landing in the normal, stacking position 25 or either of the undesired, non-stacking positions 26A and 26B will successfully intercept the infrared radiation beam 24 and hence can be detected.

Figure 4 shows a fourth example of sheet stacking hopper 30. In common with the third example, the infra-red sensor 32 is located on the base 30A of the hopper 30. However, there is only one mirror 33, located on a side wall 30B of the hopper 30, which reflects the infra-red radiation beam 34 emitted by the infra-red emitter 31 so that it can be detected by the infra-red sensor 32.

Sheets landing in either the normal, stacking position 35 or the undesired, non-stacking position 36 will intercept the infra-red radiation beam 34 and hence be detected.

This kind of sheet stacking hopper is particularly useful in banknote handling machines where it is often required to stack the notes for presentation to the operator. The banknote handling machine control system must be able to detect the presence of notes in its stacking hoppers so that, for example, the removal of all notes from the hopper can be checked.

CLAIMS

1. A sheet stacking hopper having a base on which sheets are stacked in use; and a sheet detection system comprising a pair of transducers, the first transducer emitting energy and the second transducer being sensitive to this energy, and at least one reflector arranged to reflect the emission from the first transducer so that it can be detected by the second transducer, wherein the emission from the first transducer is intercepted and modulated, if a sheet is present in the energy path between the first and second transducers, characterized in that the transducers and reflector(s) are located such that the emission from the first transducer is intercepted by a sheet stacked on the base and by a sheet supported in a non-stacked manner in the hopper.

2. A sheet stacking hopper according to claim 1, wherein the reflector is located on the base.

3. A sheet stacking hopper according to claim 1 or claim 2, wherein the hopper comprises at least one side wall, the or a reflector being located on the at least one side wall.

4. A sheet stacking hopper according to claim 3, wherein the hopper comprises a pair of side walls, a respective reflector being located on each side wall.

5. A system according to any of the preceding claims, wherein the first transducer emits electromagnetic radiation and the second transducer is sensitive to electromagnetic radiation.

6. A hopper according to claim 5, wherein the electromagnetic radiation is in the infra-red waveband.

7. A hopper according to any of the preceding claims, wherein the energy emitted by the first transducer forms a beam directed towards the at least one reflector.

8. A hopper according to any of the preceding claims, wherein the or each reflector is an optical mirror.

9. A hopper according to any of the preceding claims, wherein the first transducer is a light emitting diode.

10. A hopper according to any of the preceding claims, wherein the second transducer is a photodiode.

11. A hopper according to any of the preceding claims, the hopper having a sheet receiving opening, wherein the transducers and reflector(s) are arranged such that the energy emission is directed along a path which traverses across the sheet receiving opening.

12. A hopper according to claim 11, wherein the path traverses the sheet receiving opening more than once.

13. Sheet handling apparatus comprising at least one sheet stacking hopper according to any of the preceding claims.

14. Apparatus according to claim 13, wherein the sheet handling apparatus is a banknote handling machine and the sheets to be stacked in the sheet stacking hopper are banknotes.

Fig.1.

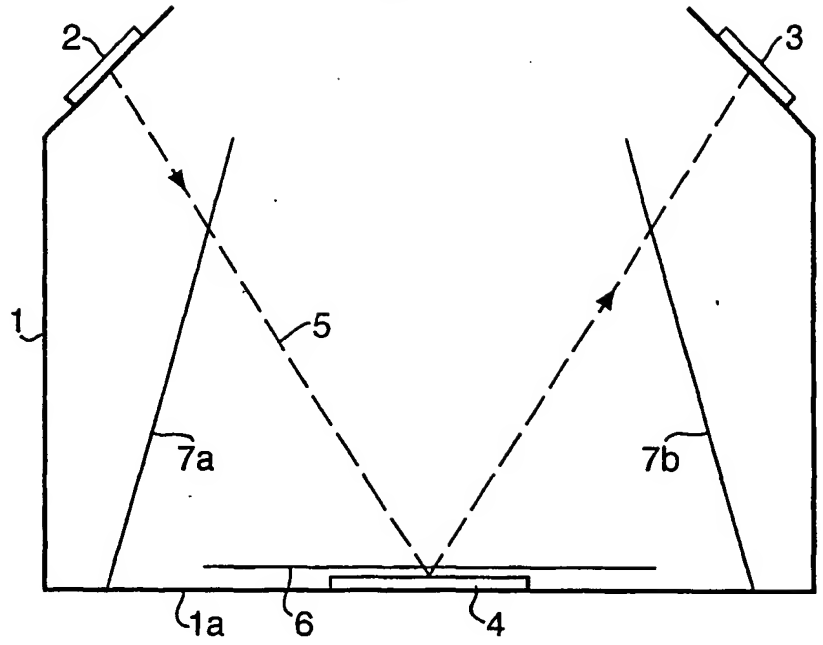


Fig.2.

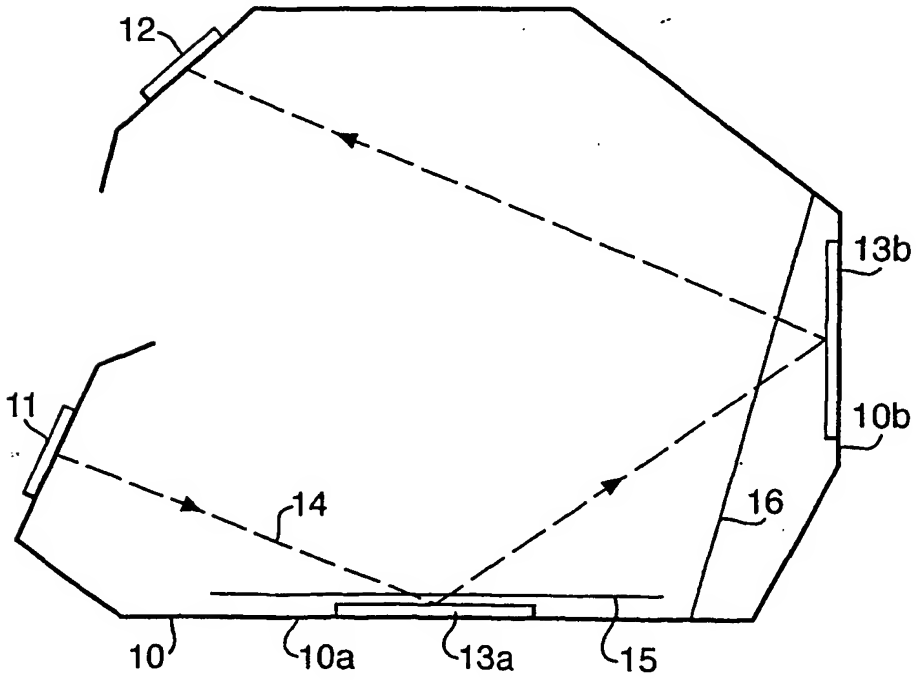

Fig.3.

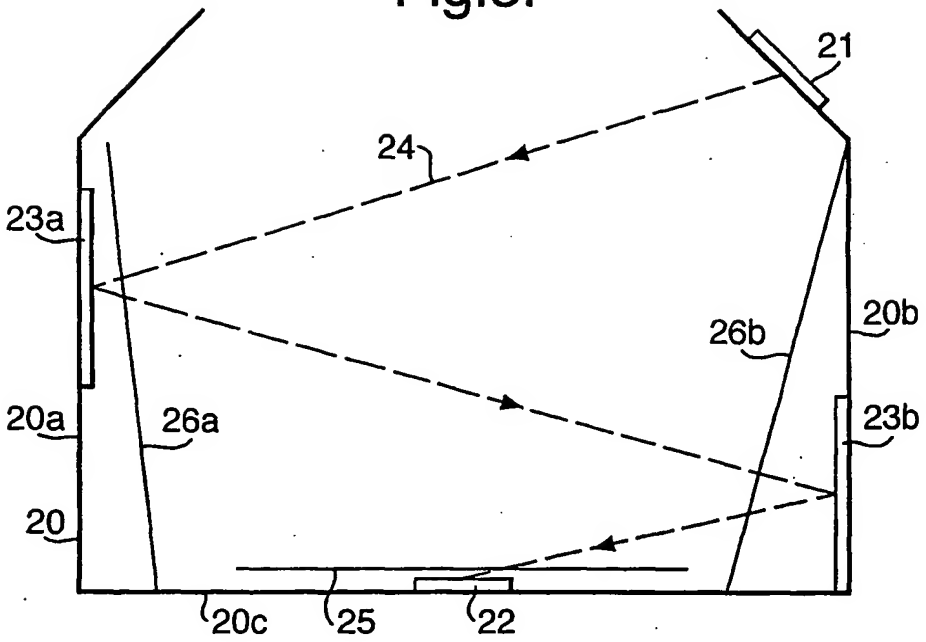
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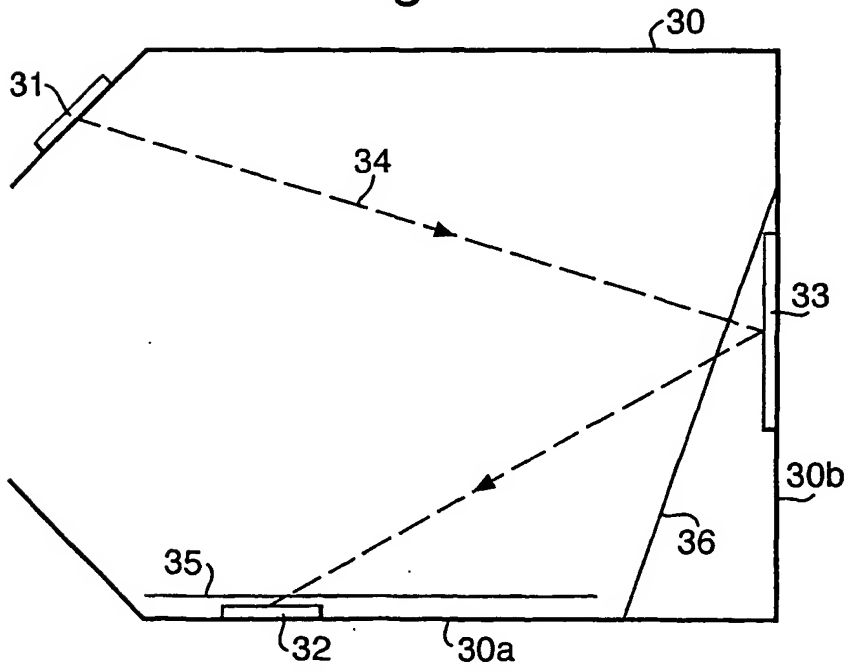
Fig.4.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# INTERNATIONAL SEARCH REPORT

Interna I Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B65H7/14 B65H7/04 B65H1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B65H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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| A | column 1, line 11 - line 35<br>column 2, line 62<br>column 3, line 35 - line 58<br>figures 1,2,4<br>--- | 11 |
| | -/-- | |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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